

Computational Tool for Coupled Simulation of Nonequilibrium Hypersonic Flows with Ablation, Phase I

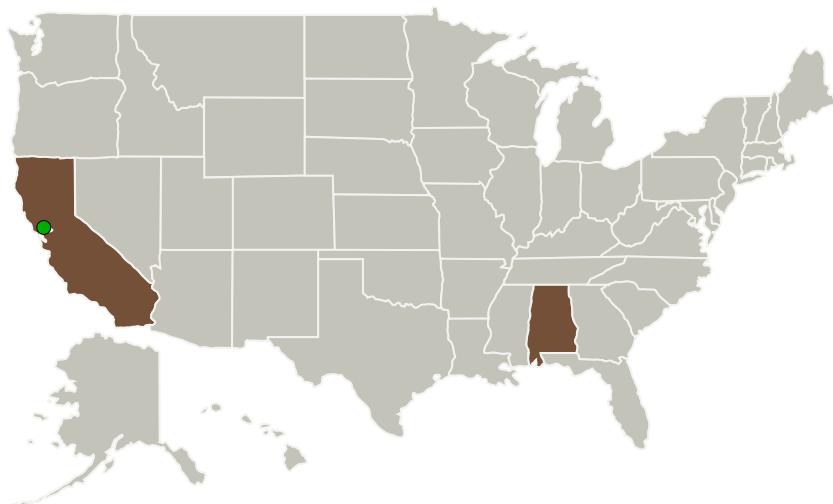
Completed Technology Project (2010 - 2010)



Project Introduction

The goal of this SBIR project is to develop a computational tool with unique predictive capabilities for the aerothermodynamic environment around ablation-cooled hypersonic re-entry vehicles. The framework for this tool will be developed such that all relevant models can be coupled to the LeMANS code for nonequilibrium hypersonic flows and the MOPAR code for ablation material response, both developed by the University of Michigan. In the proposed effort, the existing LeMANS-MOPAR framework will be enhanced by including innovative models for: (1) Non-equilibrium surface thermochemistry; (2) Non-equilibrium pyrolysis chemistry; (3) Radiation transfer in media with orders of magnitude variation in optical thickness; and (4) Spallation. The proposed tool is comprehensive and unique because all important phenomena will be modeled, with the software framework enabling coupling between the various components. The Phase I focus will be to: (1) Develop a module for the Modified Differential Approximation (MDA) to solve the radiative transfer equation; (2) Develop a framework for coupling the MDA module to LeMANS-MOPAR; and (3) Demonstrate the coupled framework for cases such as the Stardust re-entry. In Phase II, the tool will be made comprehensive by implementing important models identified above, including advanced non-equilibrium, non-gray radiation model. The tool will be validated and applied to re-entry ablation flows relevant to NASA. We will team with an ablative material OEM and a CFD software vendor to transition the technology to industry.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
Alabama	California

Project Transitions

January 2010: Project Start

July 2010: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/140123>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

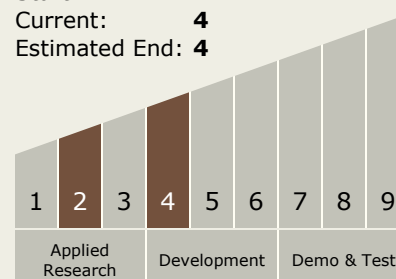
Carlos Torrez

Principal Investigator:

Sarma Rani

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4



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Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
 - └ TX09.4 Vehicle Systems
 - └ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System